International Journal of Engineering & Technology, 7 (4.43) (2018) 122-126

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Short communication



Effect of Probiotics (EM-1) Addition on Quality Characteristics of Quail Meat

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Abstract

The objective of the present study is to see the effect of probiotics (EM-1) used in animal fed as supplement on the meat quality of quails. The quails that been used in this study was from breed *Cortunix japonica*. Along the study, the quails were divided into four groups which are control quails and quails that feed with 1 L probiotics in different ratio concentration drinking water (mL) (1:250, 1:500, and 1:750). After 42 days, all the quails were slaughtered and then the carcass and meat yield of each groups was determined. Then, the meat undergo physicochemical and nutritional analysis. The value of carcass yield both in male and female quails treated with EM-1 showed a higher significant differences ($p < 0.05$) compared to control quails and no significant differences ($p < 0.05$) were showed in meat yield. Significantly higher L* and pH values ($p < 0.05$) in whole leg, were found when quails were fed the EM-1 (1:500). While in cooked quail meats no significant different ($p < 0.05$) were showed in cooking loss, juiciness and shear force analysis between the treatments. In quail meat sausages no significant different ($p < 0.05$) were showed in cooking loss, juiciness, folding test and shear force analysis between the treatments but in texture profile analysis, treatments 1:500 showed significantly higher values ($p < 0.05$) of hardness, springiness and cohesiveness compared to other treatments. Addition of this probiotics are therefore contributed to some improvements in the meat quality.

Keywords: *Cortunix japonica, EM-1, Carcass Yield, Meat Yield, Physicochemical Analysis.*

1. Introduction

Elimination of antibiotics usage from poultry production had encouraged intensive research for alternatives method to be used [1]. One way is to use specific feed such as probiotics to positively affect animal performance and welfare [2]. According to Fuller, [3], probiotics are microorganisms that are fed to animals which colonize the intestinal environment and also promote better flora balance. The most commonly bacteria used in the production of probiotics are *Lactobacilli* species (sp.) and *Streptococci* sp. [4]). The addition of probiotics in poultry show beneficial effects on growth performance poultry [5]. Addition of probiotics to poultry feed also can improve the meat quality as reported by a few studies, dietary probiotic supplements which added to chicken could improve meat quality attributes, such as water-holding capacity (WHC), tenderness, lipid oxidation stability, sensory properties, and microbial safety [6].
According to Food and Agriculture Organization (FAO) data as cited in Marangoni et al. [7], the consumption of poultry meat has progressively increased from the past century to today in Europe and in the USA and has generally remained stable over the past years. Awan et al. [8] reported that the usage of poultry meat and its products has grown in the world and over the last few years and quail meat also has showed attractiveness among consumers. In Malaysia, quail production is increasing to meet the high demand for the quail industry. East Coast Economic Region (ECER) secretariat reported that the demand of the quail has increased 20-25% each year since 1995 [9]. The valuable taste dietary properties of quail meats are important in determining the growth of interest consumers to this product. Poultry meat quality is important matters because it will affect the consumer choice in choosing poultry meat [10].
The objectives of this study was to determine the carcass yield and physicochemical properties (color, pH, water holding capacity, cooking loss, juiciness, texture profile analysis and Warner-Bratzler shear force) between of control quail and quail feed with different ratio probiotics supplement (EM-1)

2. Materials and Methods

2.1. Sample preparations

The quails were divided into four groups which are control quails (100% water) and quail feed with EM-1 supplement. This probiotic was mixed with water and changed daily. Group of quails that been supplemented with this probiotic are divide into three categories depends on the ratio between probiotic and water which are 1 litre EM-1 + 250 litre water, 1 litre EM-1 + 500 litre water and 1 litre EM-1 + 750 litre water.

2.2. Carcass & meat yield analysis

After 42th days, all the quails were slaughtered and after the slaughtering process, the quails were undergo scalding process to remove the feathers. After the quail had been scalded, the quails

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were eviscerated and the carcass of the quails were weighed by using digital scale. The calculation of carcass yield were weighed separately where the percentage ratio to the weight of body during slaughtering will be identified. The carcass yield which is not include feet, head, and neck acts as part of the weight quail at the slaughtering. After the process of carcass yield determination, the carcass were deboned and the meat of the quails were used to determine the meat yield and also in the analysis.

2.3. Cooked quail meat

Kim et al., [11] method was used to cook the meat. A piece of meat from breast was placed on the beaker and cooked in water bath at 80^{o}C for one hour until core temperature achieve above 72^{o}C. The cooked sample were cooled to room temperature for 3 hours before undergo analysis.

2.4. Quail meat sausage preparation

Muhammad et al., [12] method was used in preparation of quail meat sausage with some modification on the ingredient. Quail meat sausage was prepared by mixing 6.5% cold water, 6.5% ice, 3% salt, and 84% quail meat for 2 min using a cutter mixer. The samples were stuffed into 2.5 cm diameter sausage casings. The stuffed samples were cooked at 36 °C for 30 min, followed by heating at 90 °C for 10 min in a water bath. Quail meat gels were cooled in ice water for 30 min and stored in a chiller overnight prior to analysis.

2.5. Color measurement

Meat color was evaluated by the L* (lightness), a* (redness), b* (yellowness) system using a Konica Minolta CR-400 Chroma meter to determine the calorimetric index of chromaticity.

2.6. Determination of Ph

The pH values of meat samples were determined by using pH meter. About 5 g of meat sample was homogenized with 40 ml of deionized water then was transferred into beaker and the electrode was put into the beaker to record the pH value. The electrode was rinsed with distilled water after each measurement.

2.7. Water holding capacity

Ismail et al., [13] method was used to determine the water holding capacity (WHC). The WHC of samples were determined by homogenizing 20 g sample with 40 mL of distilled water by a blender for 30 s. About 20 g of aliquot of the homogenate was weighed into centrifugation tubes and thereafter centrifuged at 5^{o}C at low speed (1000 g for 15 min). The WHC was determined as liquid loss and expressed as percentage of weight of liquid release.

$$\text{WHC (\%)} = \frac{(\text{before centrifuge weight} - \text{after centrifuge weight})}{(\text{before centrifuge weight})} \times 100$$

2.8. Juiciness

Benjakul et al., [14] method was used to determine the juiciness of cooked quail meat and quail meat sausage. For cooked quail meat, the samples were cut into pieces with a knife and weighed while for quail meat sausage, the samples were cut into a thickness of 5 mm then were weighed. The samples were placed between two Whatman Filter No. 40 at the bottom and top of the samples. Then it were pressed for 2 m by 5 kg force. The residue was weighed. The percentage of juiciness was determine as follows:

$$\text{Juiciness (\%)} = \frac{\text{weight of the pre-pressed sample (g)} - \text{weight of the pressed sample (g)}}{\text{weight of the pre-pressed sample (g)}} \times 100$$

2.9. Cooking loss

Cooking loss was calculated as the difference between the initial and the final sample weights.

$$\text{Cooking loss (\%)} = \frac{\text{weight of sample after cook (g)} - \text{weight of sample before cook (g)}}{\text{weight of sample before cook (g)}} \times 100$$

2.10. Folding test

The folding test was determined according to Lanier [15]. The quail meat sausage samples were cut into 5 mm thick portions. The slices were held between the thumb and the forefinger and folded to observe the way that they broke. The scale used was as: (1) breaks by finger pressure, (2) cracks immediately when folded in half, (3) cracks gradually when folded in half, (4) no cracks showing after folding in half and (5) no cracks showing after folding twice.

2.11. Shear force and Texture profile analysis (TPA)

Shear force and TPA (hardness or tenderness, cohesiveness, springiness and chewiness) were determined by using TA.XT Plus texture analyzer according to the method of Bourne [16]. Warner-Bratzler knife blade with 30 kg load cell, pre-test speed 3.0 mm/s, test speed is 1.0 mm/s, post-test speed 3.0 mm/s. and down stroke distance 30.0 mm used for shear force determination. The cooked quail meat samples were cut to 1 cm × 1 cm strips while quail meat sausage samples were cut into a thickness of 5 mm. For every 0.01 second, the resistance of the meat sample to shearing was recorded and plotted by a computer in a force-deformation plot. For TPA analysis, the sample of meat was paced under the spherical probe that move downwards at a constant speed of pre-test 3.0 mm/s, test 1.0 mm/s, post-test 3.0 mm/s and the trigger type used was auto and trigger force. For the TPA measurement, the quail meat sausage samples were cut were cut into a thickness of 5 mm. Each cut were placed between stainless plates with the probes of texture analyzer which would penetrate the cut meat. The calculation of TPA values were obtained by graphing a curve using force and time plots record from the software.

2.12. Statistical analysis

IBM SPSS Statistics 20.0 software was used in this experiment to conduct the statistical analysis. One way Analysis of variance (ANOVA) was used to intemperate and compare the data obtain in this experiment.

3. Results and Discussion

3.1. Carcass and meat yield analysis

Table 1 shows the carcass and meat yield of male quails. No significant difference ($p < 0.05$) was observed for the treatments of EM-1 on the live weight. In the treated groups, the highest live weight of quails was EM 1:250 at 256.67 g and the lowest live weight of quails was EM 1:750 at 247.50 g. Narinc et al. [17] reported that the breast which was 27.45% of the body weight is one of the important and valuable part of the carcass. Study by Genchev et al. [18] reported that, the yield of breast meat in male quails was 20.80%. The relative proportion of breast meat was

high in the treated quails compared to control quails but there are no significance difference ($p < 0.05$) between the samples. The highest breast meat proportion in the treated quails was EM 1:500 at 26.55% and the lowest breast meat proportion was EM 1:250 at 23.42%.

Table 1: Carcass and meat yield of male and female quails.

Treatment	Live weight (g)	Carcass yield (%)	Breast meat (%)	Whole leg meat (%)
Male quail				
Control	254.17^{a}±19.85	64.93^{c}±1.62	24.17^{a}±1.05	13.65^{a}±0.921
EM 1:250	256.67^{a}±24.63	70.13^{b}±4.58	23.42^{a}±2.67	13.21^{a}±0.04
EM 1:500	254.17^{a}±15.94	75.72^{a}±1.59	26.55^{a}±1.67	15.53^{a}±1.00
EM 1:750	247.50^{a}±12.14	72.19^{a}±3.44	23.48^{a}±2.35	14.33^{a}±0.09
Female quail				
Control	259.17^{a}±21.08	66.28^{b}±1.43	24.65^{a}±0.36	14.37^{a}±0.35
EM 1:250	252.50^{a}±12.55	67.98^{b}±2.27	23.35^{a}±1.54	12.73^{a}±2.46
EM 1:500	255.83^{a}±22.68	75.65^{a}±2.24	26.52^{a}±0.04	15.53^{a}±0.33
EM 1:750	249.17^{a}±15.63	72.67^{a}±4.05	24.79^{a}±2.18	14.68^{a}±1.77

Each value is expressed as mean ± SD.
$^{a-c}$Means with the different letter within the same column are significantly different ($p< 0.05$).

There are significant difference ($p < 0.05$) between EM 1:500, control and EM 1:250. However there are no significant difference ($p < 0.05$) between EM 1:250, EM 1:500 and EM 1:750. There are no significance difference ($p < 0.05$) between the control quails and treated quails in whole leg meat proportion.

The female quails treated with probiotics showed a reduction in live weight compared to control female quails because due to loss of feather during rearing period, however there are no significance ($p < 0.05$). The highest value of carcass yield was quails treated with EM 1:500 at 75.65% and the lowest value of carcass yield was control quails at 67.01%. There are significance different ($p < 0.05$) between EM 1:500, control and EM 1:250. In the breast meat proportion, the highest proportion in was the treated quails with EM 1:500 at 26.52% and the lowest breast meat proportion was EM 1:250 at 23.35%. There are no significance difference ($p < 0.05$) between the control quails and treated quails in breast meat proportion. While in whole leg proportion, the highest proportion was EM 1:500 at 15.53% and the lowest proportion was EM 1:250 at 12.73%. There are no significance difference ($p < 0.05$) between the control quails and treated quails in whole leg meat proportion.

3.2. Color characteristics, pH value and WHC of quail meats (breast and whole leg part)

Colour are important quality attributes that affect selection and acceptability of many foods. According to Ribarski et al. [19], meat color depends on the amount of heme pigments, and mostly onmyoglobin (Mb) and the post mortem chemical alterations it suffers.The color characteristics of L*, a* and b* of breast part and whole leg part are presented in Table 2.

In color measurement of breast, control quails showed a higher difference ($p < 0.05$) between the four groups in value of lightness (L*). There are significance different ($p < 0.05$) between treated and control quails where the treated quails showed an increment compared to control quails in a* value. There are no significance difference ($p < 0.05$) between the control quails and treated quails in b* value.

Table 2: Color characteristics of quail meats on the breast ad leg part.

Treatment	L*	a*	b*
Breast			
Control	49.93^{a}±2.12	6.33^{b}±0.44	9.73^{a}±0.98
EM 1:250	43.92^{b}±1.15	9.57^{a}±1.22	11.01^{a}±3.07
EM 1:500	42.59^{b}±1.53	11.02^{a}±1.14	10.18^{a}±1.38
EM 1:750	45.84^{b}±3.15	8.95^{a}±2.19	8.93^{a}±0.65
Leg			
Control	44.92^{b}±0.84	7.36^{a}±0.41	7.15^{bc}±0.45
EM 1:250	44.05^{b}±2.30	5.19^{b}±1.15	5.91^{c}±1.59
EM 1:500	47.54^{a}±1.68	6.96^{a}±1.24	8.28^{ab}±1.30
EM 1:750	44.34^{b}±1.31	8.11^{a}±0.45	9.50^{a}±1.25

Each value is expressed as mean ± SD.
$^{a-c}$Means with the different letter within the same column are significantly different ($p < 0.05$).

In color measurement of whole leg, the highest value of lightness (L*) was quails treated with EM 1:500 at 47.54 and the lowest value of L* was treatment EM 1:250 at 44.05. Quails treated with EM 1:500 had a significantly higher lightness (L*) values ($p < 0.05$) compared to other quails. In the study by Liu et al. [20] that carried out on the effect of addition of *Lactobacillus johnsonii* BS15 on broiler chicken meat showed an improvement in color characteristics of breast and whole leg part of broiler chicken especially in L* and b*.

The pH values of breast part showed lower value compared to the pH values of whole leg part. The pH value of breast and whole leg part is presented in Table 3. According to Genchev et al. [18], the pH values of meat depended on glycogen content in muscles, and glycogen stores are highly influenced by the locomotors activity and the presence of stress factors during pre-slaughter. The pH values in the breast showed no significant difference ($p < 0.05$) between the control quails and treated quails. Treated quails had a significantly higher pH values in the whole leg ($p < 0.05$) compared to control quails. In the study from Kim et al. [11], increase in probiotic feeding had increased the pH value of breast muscles of chickens. From the previous study by Chen et al. [21], the addition of *Lactobacillus salivarius* into the chickens fed showed an improvement in pH value (6.33) in breast and thigh muscle compared to control (6.15).

Table 3: pH and WHC values of the quail meat at the breast and whole leg part.

Treatment	pH	WHC
Breast		
Control	5.78^{a}±0.05	33.06 ^{ab} ±3.57
EM 1:250	5.79^{a}±0.07	27.42 ^{b} ±3.87
EM 1:500	5.74^{a}±0.22	34.49 ^{ab} ±5.64

EM 1:750	5.81[a]±0.11	40.02[a] ±7.34
Leg		
Control	6.39[b]±0.05	117.25[a] ±17.79
EM 1:250	6.76[a]±0.04	115.99[a] ±8.67
EM 1:500	6.72[a]±0.05	86.06[b] ±23.89
EM 1:750	6.69[a]±0.08	95.44[ab] ±21.21

Each value is expressed as mean ± SD.
[a-b]Means with the different letter within the same column are significantly different ($p < 0.05$).

WHC is defined as the ability of meat to retain moisture [22]. WHC of quail meat determines how long the quail meats are able to hold water when pressure is imposed in a centrifuge. WHC of quail meat at breast and whole leg part is shown in Table 3. In the breast water holding capacity (WHC) values, treated quails showed a different value between the four groups. There are significant different ($p < 0.05$) between treatment EM 1:750 and EM 1:250 and showed no significantly different between control quails and treatment EM 1:500.

While in the whole leg WHC values, treated quails also showed a different value between the four groups. There are significant different ($p < 0.05$) between control quails, treatment EM 1:250 and treatment EM 1:500. There are many factors that affecting the WHC of the meat such as during pre-mortem time duration likes grow time, diet and stresses and also post mortem time duration likes chilling, ageing and tumbling [23]. A higher WHC is very important to the food industry, as it correlate positively to minimize the decrease of the final product [24].

3.3. Cooking loss, juiciness and shear force of cooked quail meats.

All the cooked meat sample had undergo analysis of cooking loss, juiciness and cooking loss and the results are shown at the Table 4.

Table 4: Cooking loss, juiciness and shear force value of cooked meat.

Treatment	Cooking loss (%)	Juiciness (%)	Shear force (N)
Control	17.62[a]±0.38	19.86[a]±0.04	10.62[a]±0.44
EM 1:250	20.52[a]±0.73	18.20[a]±1.42	8.63[a]±2.06
EM 1:500	14.02[a]±0.57	20.30[a]±0.26	10.87[a]±0.45
EM 1:750	14.67[a]±4.85	20.92[a]±3.77	10.50[a]±0.39

Each value is expressed as mean ± SD.
[a]Means with the same letter within the same column is not significantly different ($p < 0.05$).

There are no significance difference ($p < 0.05$) between the control quails and treated quails in cooking loss value. There are also no significance difference ($p < 0.05$) between the control quails and treated quails in juiciness value. There are no significance difference ($p < 0.05$) between the control quails and treated quails in shear force value. Study from Kim et al. (2016), also showed that cooking loss of 3 chicken groups was significantly unaffected ($p < 0.05$) by probiotic supplement. Pelicano et al. [25] also reported that addition of probiotics quail diets was not significantly affected ($p < 0.05$) even though increased in cooking loss. This is due to further release of unbound and entrapped water from myofibrillar matrix due to heat-induced muscle fiber shrinkage during cooking [26, 27]. Lyon & Lyon [28] reported that if the Warner Bratzler shear force in kg is less than 3.61 (35.40 N) the chicken breast meat is considered as very tender and if it is between 3.62 - 6.61 (35.50 - 64.82 N) it is considered as moderately slightly tender.

3.4. Cooking loss, juiciness, and folding test of quail sausages

No significant difference ($p < 0.05$) were observed in cooking loss, juiciness and folding test between control sausages and sausages made from treated quails with probiotics EM-1. Value of juiciness, cooking loss, diameter reduction and folding test of sausage were showed in the Table 5.

Table 5: Cooking loss, juiciness and folding test of quail sausage.

Treatment	Cooking loss	Juiciness	Folding test
Control	5.97[a]±0.07	16.99[a]±0.34	3.00[a]±0.00
EM 1:250	4.91[a]±1.04	16.37[a]±1.43	2.50[a]±0.71
EM 1:500	3.86[a]±0.29	14.86[a]±0.09	3.50[a]±0.71
EM 1:750	4.26[a]±0.72	17.23[a]±1.29	2.00[a]±0.00

Each value is expressed as mean ± SD.
[a]Means with the same letter within the same column is not significantly different ($p < 0.05$).

The highest value of cooking loss in sausage was control quails at 5.97% and lastly was treatment EM 1:500 at 3.86%. While in juiciness of sausage, quails treated with EM 1:750 has the value at 17.23% which recorded as the highest value of juiciness and lastly treatment EM 1:500 at 14.86%. The highest score of folding test in sausage was quails treated with EM 1:500 at 3.50% and lastly was treatment EM 1:750 at 2.00%. The highest value of shear force in sausage was recorded in quails treated with EM 1:500 at 4.21 N and lastly control quails at 3.12 N.

3.5. Shear force and Texture analysis of quail sausage

Sausage of quail meats was undergo texture analysis where the value of hardness, springiness, cohesiveness and chewiness of sausage were determined and showed in Table 6.

Table 6: Hardness, springiness, cohesiveness and chewiness value of quail sausage.

Treatment	Shear force (N)	Hardness (g)	Springiness	Cohesiveness	Chewiness (gmm)
Control	3.12[a]±0.02	2001.79[c]±86.24	0.73[b]±0.02	0.32[a]±0.02	467.36[c]±21.24
EM 1:250	3.86[a]±0.01	2859.71[a]±84.29	0.71[b]±0.04	0.32[a]±0.01	641.90[b]±39.86
EM 1:500	4.21[a]±0.85	2920.11[a]±160.31	0.80[a]±0.02	0.36[a]±0.03	838.09[a]±14.34
EM 1:750	4.00[a]±0.24	2468.40[b]±185.05	0.71[b]±0.03	0.30[a]±0.03	529.50[c]±86.04

Each value is expressed as mean ± SD.
[a-c]Means with the different letter within the same column are significantly different ($p < 0.05$).

Sausages made from EM 1:500 showed the highest value of hardness (2920.11 g), followed by those using meat from EM 1:250 (2859.71 g), meat from EM 1:750 (2468.40 g) and meat from control (2001.79 g). In hardness, treatment of EM 1:250 and treatment EM 1:500 showed a significantly higher value of hardness ($p < 0.05$) compared treatment EM 1:750 and control. In springiness, sausage made from EM 1:500 showed significantly higher values ($p < 0.05$) at 0.80 followed by control at 0.73, EM 1:250 and EM 1:750 at 0.71. However there are no significant difference ($p < 0.05$) between control, treatment EM 1:250 and treatment EM 1:750. There are no significance difference ($p < 0.05$) between the sausage made from control quail meat and sausage made from treated quail meat in cohesiveness value. Significant differences ($p < 0.05$) was observed for chewiness between samples from the different treatment.

4. Conclusion

Probiotics EM-1 gives a positive effect towards carcass and meat yield in male and female quails compared to control quails. EM-1 can also improve some of the meat quality characteristics of quail meat and treatment with EM 1:500 is consider as the most prefer concentration of probiotics EM-1.

Acknowledgement

The authors acknowledge with gratitude the support provided by Universiti Sultan Zainal Abidin to conduct research in the area Food Science and Technology through research grant UniSZA/2017/DPU/11.

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